SP-F16 Evaluation of Project Effects on Instream Flows and Fish Habitat

February ~~18~~28, 2002

1.0 Introduction/Background

In 1995, the Feather River Technical Team (FRTT) of the Anadromous Fish Restoration Program Core Group listed instream flows as the key limiting factor for Chinook salmon and steelhead production in the Feather River (USFWS 1995). The FRTT further suggested that inadequate flows may limit spawning and rearing habitat for anadromous salmonids.

Minimum flows in the ~~lower~~ Feather River below the Fish Barrier Dam were established by a 1983 agreement between Department of Water Resources (DWR) and California Department of Fish and Game (DFG). The agreement establishes criteria for flow and temperature for the reach of the Feather River from the Fish Barrier Dam to the Thermalito Afterbay outlet ~~(Low Flow Channel (LFC) of the Feather River~~ and the reach of the Feather River below the Thermalito Afterbay outlet to the confluence with the Sacramento River for preservation of salmon spawning and rearing habitat (DWR 2001). The agreement specifies that DWR release a minimum of 600 cfs below the Fish Barrier ~~into the LFC~~ for fishery purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline. The agreement also specifies minimum flow requirements in the ~~lower reach of the~~ Feather River downstream of the Thermalito Afterbay outlet ranging from 1200-1700 cfs during the primary spawning and incubation period (October-February), and from 1,000-1,700 cfs during March, dependent upon Lake Oroville storage (greater than 733 feet) and normal unimpaired runoff (1,942,000 acre-feet) near Oroville. There is an additional requirement for ~~the lower~~this reach that if, from ~~during~~ October 15 through November 30, the hourly flow is greater than 2,500 cfs, then the minimum flow must be maintained at no less than 500 cfs below the hourly flow until the following March unless the high flow was due to flood control operation or mechanical problems. This requirement is to protect any spawning that could occur in overbank areas during the higher flows ~~rate~~ by maintaining high enough flows ~~levels high enough~~ to keep the overbank areas submerged. In practice, the flows are maintained below 2,500 cfs from October 15 to November 30 to prevent spawning in the overbank areas (DWR 2001).

The FRTT suggested that instream flow studies be completed to determine what flows might be required to enhance the river's salmonid stocks. Additional flow between the Fish Barrier and Thermalito ~~through the low-flow channel during at least~~from September through May could enhance spawning habitat without an adverse effect on rearing (USFWS 1995). Initial results from a jointly conducted DWR and DFG instream flow study utilizing Physical Habitat Simulation (PHABSIM) suggested that spawning habitat in the LFC would be maximized at higher flows than the present level of 600 cfs (Sommer 1994). Additional ~~Physical Habitat Simulation (~~PHABSIM~~) study results~~ analysis suggests that the maximum area of suitable spawning habitat in the LFC was indicated to occur at a flow of ~~about~~ approximately 1,000 cfs. In the fifteen miles of river between the Thermalito Afterbay Outlet and Honcut Creek (known as the High Flow Channel or HFC), maximum suitable spawning habitat area was ~~present~~ indicated to occur at a flow of about 3,250 cfs (Sommer et al. 2001).

2.0 Study Objectives

The general objective of this study plan is to analyze flow-habitat relationships to evaluate potential project effects on anadromous salmonid spawning and rearing habitat within the study area. This study plan is designed as a two-phased approach with multiple objectives. The Phase 1 objective is to ~~analyze~~ examine the ~~current/previous IFIM/~~existing PHABSIM studies for their applicability to the needs of FERC Oroville Relicensing study plans. This includes an evaluation of the changes in the Feather River since these other studies were completed, as those changes apply to determination of the amount of available habitat. Additionally, this evaluation will include an assessment of the habitat suitability criteria generated in previous PHABSIMs, as well as recent habitat utilization data collected by DWR. ~~IFIMs.~~ The ~~Phase 2~~ objective of Phase 2, if necessary, will be to collect additional hydraulic or biologic data to supplement existing data for direct applicability to FERC Oroville Facilities Study Plans. Additionally, thi~~s~~e study plan will establish tools to evaluate future potential operational scenarios and other protection, mitigation and enhancement measures (PM&Es) ~~measures~~.

3.0 Relationship to Relicensing/Need for Study

Conceptual Framework: Oroville Facilities project operations influence the water flow (i.e., volume, flow rate, fluctuations) and water temperature released into the LFC and the ~~High Flow Channel (~~HFC~~)~~ of the Feather River. The~~se~~ effects on flow and temperature potentially influence salmonid habitat suitability and availability, and therefore salmonid spawning and rearing in the ~~lower~~ Feather River below the Fish Barrier Dam.

Flows released below hydroelectric projects are intended to protect, maintain, and enhance the aquatic ecosystem and, more specifically, those resources considered important from a commercial fishery, sport fishery, or threatened/endangered species perspective. Instream flows are almost universally specified in a FERC license and should be based on relevant site-specific information from the project area. Resource agencies participating in FERC relicensing processes commonly rely on information generated from PHABSIM instream flow studies to develop recommended instream flow regimes. FERC also will use these types of studies during their resource balancing deliberations prior to issuing long-term licenses.

Additional evaluations are needed to verify or identify appropriate instream flow levels in the ~~lower~~ Feather River below the Fish Barrier Dam. Additional analyses of existing data (site-specific or generic) using recent modeling and analytical techniques ~~may~~ will help reduce uncertainty associated with previous analyses and improve the applicability of PHABSIM results to water ~~-~~management decisions. These analyses also may identify data supplementation and augmentation necessary to develop satisfactory flow-habitat relationships.

Section 4.51(f)(3) of 18 CFR requires reporting of certain types of information in the FERC Application for License for major hydropower projects, including a discussion of the fish, wildlife and botanical resources in the vicinity of the project. The discussion needs to identify the potential impacts of the project on these resources, including a description of any anticipated continuing impact for on-going and future operations of the project. In addition to fulfilling these requirements, information developed in this study plan also may be used in determining appropriate ~~protection, mitigation and enhancement~~ (PM&Es) ~~measures~~ or other management actions for the project.

4.0 Study Area

The proposed ~~lower Feather River~~ study area for the Phase 1 evaluation consists of the ~~is~~ 23.25 miles of the Feather River between the Fish Barrier Dam and Honcut Creek~~long and~~, which consists of two river segments. The first segment ~~is the LFC, which~~ extends from the Fish Barrier Dam at river mile (RM) 67.25 to the Thermalito Afterbay Outlet (RM 59). Substrates in this segment~~LFC~~ are composed of relatively large elements with armoring due to transport of gravels downstream out of the area (Sommer et al. 2001). The river drops a total of 37 feet in this 8.25 mile-long segment, for a stream gradient of about 0.08 percent.

The second river segment is the ~~lower~~ reach of the Feather River~~,~~ which extends from the Thermalito Afterbay Outlet downstream to the confluence with Honcut Creek, near Live Oak (RM 44). ~~This reach is also referred to as the HFC.~~ The substrate in this segment of the Feather River tends to include relatively small gravel-sized particles transported ~~downstream~~ from the upstream segment~~LFC~~ (Sommer et al. 2001). Stream gradient in this 15 mile-long segment is about 0.06 percent.

If a Phase 2 data collection effort is determined to be necessary, the geographic scope of the data collection effort will be specified in the Phase 1 summary report. The Phase 1 evaluation will include a review of the collected data regarding salmonid distribution and abundance in order to recommend potential expansion or contraction of the study area for Phase 2, if necessary. ~~Downstream of the study area (RM 0 to 44), the Feather River is primarily composed of slough-like, flat-water habitats with fine-grained substrates that are unsuitable for salmonid spawning. This portion of the lower Feather River, although potentially utilized as a rearing area and which serves as a migration corridor for salmonids, is not proposed tobe included in the detailed PHABSIM analysis.~~

Study plans and phases of study plans approved by the Environmental Work Group define the limits of the study area. If initial study results indicate that the study area should be expanded or contracted, the Environmental Work Group will discuss the basis for change and revise the study area as appropriate.

5.0 General Approach

Detailed Methodology and Analysis

The general approach of this study plan is to review and evaluate existing information, conducting additional analyses of existing data (site-specific or generic) using recent modeling and analytical techniques. This approach is intended to reduce uncertainty associated with previous PHABSIM analyses. Results of the review of existing information and additional analyses may identify additional data needs to further refine flow-habitat relationships in the study area.

This study plan is structured as a two-phased study with Phase 1 composed of three tasks. In Phase ~~I~~1, Task 1 is a review of existing studies and hydraulic and biological (habitat suitability) data. Task 2 is ~~to perform~~a review of habitat modeling simulations and Task 3 is the preparation of a summary report including identification of supplemental data needs. If it is determined that additional data are required, then field surveys (to be described in the summary report) will be conducted in Phase 2 in order to complete a satisfactory description of stream flow-habitat relationships in the ~~lower Feather River~~ study area.

If initial study results indicate that the methods and tasks should be modified, the Environmental Work Group will discuss the basis for change and revise the study plans as appropriate.

Phase 1

~~Phase 1,~~ Task 1—Review Existing Studies and Hydraulic and Biological (Habitat Suitability) Data

Task 1 will begin by obtaining and reviewing existing hydraulic (Task 1A) and biological (Task 1B) information relevant to this study plan, as described in detail below.~~including habitat maps and/or detailed aerial photographs of the project area.~~

Task 1A – Review and Reassessment of Hydraulic Data

Hydraulic data will be closely examined and evaluated using newly available hydraulic simulation software to ensure that all previous data have been adequately collected and calibrated, and that resulting weighted usable area (WUA) habitat index/discharge simulations are reliable. Of specific concern are the number and placement of transect cross-sections used to represent the study area (based on reach length, channel complexity, critical habitat coverage, and sample size considerations), the range and level of discharges used to calibrate the models (based on the difference between all measured discharges in the context of annual hydrology), and the rate and/or magnitude of river channel change (aggradation/degradation) since the data were collected.

Review of available information will include, but is not limited to, the following existing sources:

- ~~Historic stream flows in the low flow channel and below Thermalito Afterbay outlet.~~
- ~~DWR-ESO H~~hourly temperature recordings at 20 sites between the Thermalito Diversion Dam and Live Oak non-continuous records since 1997.
- ~~USGS temperature records at gage downstream from Oroville Dam, 1958 to 1992; continuous temperatures since 1995 by DWR.~~
- ~~OFD mean daily water temperatures records at the Feather River Hatchery since initiation of hatchery operations and Robinson Riffle since July 31, 2000.~~
- ~~USGS records of maximum and minimum daily water temperatures at the Thermalito Afterbay Outlet from October 1968 through September of 1992. Since 1992, mean daily water temperature data from OFD.~~
- ~~River temperature model developed by UC Davis under contract with DWR-ESO in 2000.~~
- DWR-ESO instream flow study from 1992. Thirty-two transects selected between the Fish Barrier Dam and Honcut Creek. Salmon, steelhead and American shad were the target species.
- Results from the current Oroville Facilities FERC Relicensing study plans.
- Yuba River flow-habitat studies related to anadromous fish.
- American River flow-habitat studies related to anadromous fish.
- Factors Affecting Chinook Salmon Spawning in the Lower Feather River (Sommer et al. 2001)

Specific data elements to be reviewed are listed below in two categories. The first category contains elements which should be completed as early as possible in the review cycle as the outcomes of these specific investigations may determine the disposition and direction of the remainder of the investigation, while the elements in the second category may be completed at any time during the review. Specific hydraulic data elements to be reviewed include, but are not limited to:

Category 1:

- Changes in geomorphology of the river upstream of Honcut Creek to be obtained from SP-G2
  - i. Change in proportion of each habitat type
  - ii. Change in armoring
  - iii. Status of dynamic equilibrium
- Transect locations at which hydraulic data were obtained within the two reaches of the study area (between the Fish Barrier and Thermalito Outlet, and downstream of the Thermalitio Outlet), within each channel type (straight flatwater and island bar complex), and within pools, riffles, and glide/runs and rationale for choosing the locations as they pertain to each species and lifestage, including transect weighting (chinook salmon spawning, chinook salmon rearing, steelhead spawning, steelhead rearing)

Category 2:

- Methodology and equipment used to gather hydraulic data by comparing methodologies to standard methods and equipment, and to the model requirements (chinook salmon spawning, chinook salmon rearing, steelhead spawning, steelhead rearing)
- Transects which were not used in the previous PHABSIM and review the possibility of incorporating these transect data (chinook salmon spawning, chinook salmon rearing)

Task 1B – Review and Assessment of Biological and Habitat Data

In addition to a review of the hydraulic data, the biological (habitat suitability) criteria from prior reports will be assembled and reviewed. Review items ~~would~~ will include the use of generic or site-specific criteria, the characteristics of source criteria (e.g., fish size, channel size, gradient, water temperature), data collection study design, and method of curve creation from data frequency analysis. Site-specific habitat suitability criteria for chinook salmon spawning in the Feather River have been collected by DWR (Sommer et al. 2001). These biological data will be independently reviewed before further use in habitat index/discharge simulations and will be compared to criteria published in the scientific literature, and to criteria developed for nearby rivers (e.g., lower American River and Yuba River) for similarity and applicability. It is anticipated that the recently gathered spawning habitat suitability criteria developed by Sommer et al. (2001) will be sufficient for applicability to PHABSIM models. Data required to generate habitat suitability criteria for rearing will either be extracted from existing DWR microhabitat use data collected during snorkeling surveys, or gathered by Task 3A of SP-F10. This data will include measurements of water velocity, water depth, water temperature, dominant substrate size, and cover classification for rearing juvenile anadromous salmonids observed during snorkeling surveys conducted since 1999 and in SP-F10. Frequency of use histograms will be plotted and habitat suitability curves will be generated. For spawning and rearing, existing and concurrently obtained site-specific data will be compared to criteria from other basins. The habitat suitability curves for spawning and rearing will be utilized by Task 2 to determine amount of available habitat through generation of weighted usable area estimates at various discharges.

Review of available information will include, but is not limited to, the following existing sources:

- DFG surveys conducted (using various methods) every Fall since 1954 -Annual population estimates for fall and spring run salmon returning to spawn.

- DWR-ESO study begun in Spring of 1999 -Distribution and habitat use (including riparian habitat use) of juvenile salmon and steelhead which~~,~~ utilizes snorkeling observations (March - August) on the Feather River between the Fish Barrier Dam and Gridley Bridge.
- DWR-ESO steelhead and salmon habitat use studies in 1999 and 2000 -Depth, current velocity, substrate, in-stream cover, over-head cover are recorded.
- DWR-ESO mapping studies completed in 1999~~,~~ and ~~with~~ 1992 IFIM studies - Riffles, pools, glides and backwater habitats have been delineated on aerial photographs from the Fish Barrier Dam to the Gridley Bridge.
- DWR Northern District published Feather River gravel condition reports in 1982 and 1996.
- DWR-ESO study begun in Fall 2000 regarding stranding and redd dewatering. Study will identify potential stranding areas between the Fish Barrier Dam and Honcut Creek, and attempt to quantify salmonid losses.
- DFG: An Evaluation of Fish Populations and Fisheries in the Post-Oroville Project Feather River, 1977.
- Information from reports, fish surveys and creel census performed by DFG or other agencies (e.g., Painter et al. 1977).
- 1982 DWR Feather River Spawning Gravel Baseline Study.
- Results from the current Oroville Facilities FERC Relicensing study plans.
- 2000 Spring-run and steelhead Biological Assessment.
- 2001 Spring-run and steelhead Biological Opinion.
- 1982 DWR, Upper Feather River Instream Flow Study.
- Factors Affecting Chinook Salmon Spawning in the Lower Feather River (Sommer et al. 2001)

Specific biological and habitat data to be reviewed include, but are not limited to:

Category 1:

- Locations at which site-specific habitat suitability criteria observation data were obtained within the two reaches of the study area (between the Fish Barrier and Thermalito Outlet, and downstream of the Thermalitio Outlet), within each channel type (straight flatwater and island bar complex), and within pools, riffles, and glide/runs and rationale for choosing the locations as they pertain to each species and lifestage (chinook salmon spawning, chinook salmon rearing, steelhead rearing)
- Methodology and equipment used to gather site-specific habitat suitability data by comparing to standard methods and equipment (chinook salmon spawning, chinook salmon rearing)
- Number of observations of rearing fry and juveniles, and distribution of observation data in relation to data bins, to determine if the number of observations is sufficient (chinook salmon spawning, chinook salmon rearing, steelhead rearing)
- Current snorkel surveys (including location of sampling sites, types of data collected, methods used to gather data, timing of surveys) to determine direct applicability to PHABSIM. In addition, potential survey modifications and/or augmentation measures, if necessary, for the next two field seasons, will be identified for additional application of the data collected (e.g., addition of GPS coordinates for each fish observed as validation for potential 2D modeling). Specific activities of the snorkel survey evaluation include:
    i. obtain list of equipment used by DWR personnel to obtain water depth, depth of fish, focal point velocity, and mean water column velocity

ii. obtain summary of methods used by DRW field personnel to collect hydraulic and biologic data

iii. accompany field crew personnel to the Feather River, observing the methods used to collect hydraulic and biological data

- Existing frequency-of-use microhabitat information on rearing steelhead to determine direct applicability in habitat simulations, and potential adjustment for availability
- The suitability of PHABSIM analysis in general to evaluate juvenile salmonid rearing (chinook salmon rearing, steelhead rearing)

Category 2:

- Data and methods used for availability adjustments and curve creation/fitting (chinook salmon spawning, chinook salmon rearing, steelhead rearing)
- The use of combined habitat suitability criteria (gathered at 600 cfs and 1600 cfs) versus the use of data collected at 600 cfs for predicting habitat availability expressed in terms of Weighted Usable Area (WUA), at low flows and use of data collected at 1600 cfs for predicting WUA at high flows (chinook salmon spawning)
- Whether fall run chinook and spring run chinook can be evaluated using the same habitat suitability criteria data based on other studies and size-at-time data (chinook salmon spawning)
- The size class definition of "juvenile" (chinook salmon rearing)
- The manner in which rearing should be considered for fall-run, as most fall-run emigrate as post-emergent fry and are transient at this lifestage (chinook salmon rearing)
- The criteria used to classify cover for applicability of the current cover code to PHABSIM, utility of any cover code to PHABSIM, possibility of including distance to cover, and compatibility with criteria used in the 1991 IFIM (chinook salmon rearing, steelhead rearing)
- Data describing known spawning locations for steelhead (steelhead spawning)
- Flow control in known steelhead spawning locations (steelhead spawning)
- Available information and literature describing microhabitat suitability criteria for steelhead spawning (steelhead spawning)

Examples of the types of methodologies that will be used to accomplish the Task 1 evaluation of existing data include requesting electronic data files containing site-specific microhabitat data, and arranging and sorting data files according to the following factors using spreadsheet software sorting and filtering functions: species, scale of survey (i.e. spawning data, broad-scale survey rearing data, intermediate-scale survey rearing data, fine-scale rearing data), flow, reach, year, month, channel type, mesohabitat type, channel location (bank versus midchannel), and microhabitat parameters (depth, velocity, substrate, cover). Once data has been collected and sorted, the data files will be summarized (using spreadsheet histogram and/or pie charts). Enumeration of the number of focal observations (or redds), the number of availability data points, and the level of effort (using surface area and/or CPUE) will be estimated for each factor listed above.

Following summarization by factor, the adequacy of the data will be evaluated for use in developing habitat suitability criteria (HSC). Data gaps in sampling effort, fish focal observations, and habitat availability will be identified. Potential data gaps in sampling effort will be identified by comparing effort in the following locations: bank vs. midchannel areas, deep vs. shallow areas, pools vs. riffles vs. runs, straight channels vs. island bar complexes, high flow vs. low flow channels. Potential data gaps in fish focal observations will be identified by considering the number of larger juvenile steelhead observed (compare to the recommended minimum of 150-300 observations), the estimation of mean column velocities using focal velocities, the

relationship of chinook fry to distance to cover (by comparing to the Klamath River HSC study), the suitability of deep water, and the compatibility of intermediate-scale and fine-scale rearing data. Potential data gaps in habitat availability data will be investigated by determining the correspondence of availability measurements with the focal point measurements (i.e., same location, time period, flow, etc.) and by using sensitivity analysis to estimate the effects of potential data gaps on HSC created from the available focal point observations.

After the data has been evaluated for use in developing habitat suitability criteria (HSC), HSC construction methodologies will be explored using conventional spreadsheet functions. Methods to be compared include habitat use HSC (spawning, rearing intermediate and fine-scale survey data), use/availability ratio HSC (spawning, rearing intermediate and fine-scale survey data), density HSC (rearing fine-scale rearing data), presence-absence HSC (rearing fine-scale rearing data), and "averaged" HSC.

A comparison will be conducted of site-specific Feather River HSC to HSC from other sources using visual overlays of graphs. Similarities/dissimilarities to other criteria will be evaluated. Consideration will include modifications to site-specific HSC, development of "envelope" HSC (as done in the Klamath River IFIM), and consideration of use of alternative HSC.

Task 2—~~Perform~~ Review Habitat Modeling Simulations

Once the hydraulic data and species-specific habitat suitability criteria data have been assembled and reviewed, previous habitat simulations will be evaluated. Specific elements to be reviewed will include, but are not limited to:

~~used to generate the relationship between stream flow and habitat index (WUA) in each of the study segments. The analysis will be further refined by conducting time-series analyses using hydrology since project operations began in 1968. To develop maximum utility for licensing considerations, results will be divided into seasonal periods appropriate for WUA analysis for various fish species lifestages (e.g., spawning and rearing). Additionally, by utilizing the results of Engineering and Operations Work Group Study Plans, potential project effects on habitat availability will be determined under a variety of operational scenarios.~~

Category 1:

- The applicability of PHABSIM analysis to large riverine systems such as the Feather River
- The impact of incremental hydrological change to the physical habitat model predictions

Category 2:

- The use of the middle 50% of spawning habitat suitability data versus fitting a curve to probability-of-use estimates (chinook salmon spawning, chinook salmon rearing)
- The multimodal relationship between WUA and flow occurring in the reach below the Thermalito Outlet to determine whether or not the PHABSIM results are representative of river conditions, and investigate the derivation of the multimodal relationship (chinook salmon spawning)
- PHABSIM model results, by comparing field-observed distribution of spawners (% spawning- in above and below the Thermalito Outlet) to the PHABSIM-predicted distribution of spawners. Investigate assigning confidence intervals to PHABSIM results and determine whether PHABSIM predicts a distribution that is reflected by field observations (chinook salmon spawning)
- PHABSIM model results for juvenile chinook salmon rearing to determine if variables other than flow are affecting the representativeness of the model, and develop a list of likely probable factors that may

affect the ability of the model to reflect actual conditions (may identify investigations required in SP-F10) (chinook salmon rearing)

- Quality of WUA to determine whether fewer higher quality cells or many lower quality cells constitute the resultant WUA curve by producing a cell-by-cell color-coded map in 2/10^{ths} increments (chinook salmon rearing)
- The possibility of using a targeted 2D method for supplementing existing data, as required (chinook salmon rearing, steelhead spawning, steelhead rearing)
    i. Additional information to be gained from this analysis
    ii. Proposed sites based on existing information needs or on possible sites for future restoration actions
- Methods for validating 2D models, if required

Task 3—Prepare Summary Report

Following review of existing information and data, a summary report will be prepared and circulated to reviewing resource agencies. The summary report will contain documentation of the review of existing information and a draft of the Phase 2 study plan, if necessary. The documentation of the review of existing information will fully describe the analytical procedures used to examine and develop existing information for PHABSIM application. PHABSIM generates an index to aquatic habitat suitability (weighted usable area, or WUA) as a function of stream discharge for target species and life stages. The WUA index can be interpreted in the context of stream hydrology and species life history to evaluate project impacts, and serves as a partial basis for determining project alternatives and PM&E measures. The summary report will also include the Phase 2 study plan draft, which will describe the manner in which supplemental information will be collected, if such collection is deemed necessary to develop satisfactory flow-habitat relationships. If supplemental data collection is not deemed necessary, the summary report will serve as the final report.

If supplemental data collection is necessary, then the summary report will provide a complete description of the Instream Flow Incremental Methodology (IFIM) Phase 2 scoping process. The IFIM is a structured evaluation and decision-making process involving multiple scientific disciplines and stakeholders, in the context of which PHABSIM studies are usually designed and implemented. Critical stakeholder concurrence on study scope, design elements, and overall adequacy for decision-making is one of the principal objectives of IFIM scoping (Bovee et al. 1998).

If supplemental biological data are determined to be necessary, specific experimental design, data acquisition, sampling protocols, data reduction, analytical procedures, and habitat suitability criteria development will be developed in the scoping process. If supplemental hydraulic data collection is determined to be necessary, the summary report will describe the methodology to be used. Hydraulic data may be collected using a combination of transect-based, one-dimensional and area-based, two-dimensional (2-D) techniques. The low-gradient nature of the study area, combined with the complex hydraulics created by the presence of gravel bars and mid-channel island complexes, present a set of conditions where the use of 2-D hydraulic model may be logistically and economically feasible. Additional data collection under Phase 2 would be conducted according to standard, established PHABSIM methods, including reach delineation, macrohabitat delineation ~~(as described in SP-3.2)~~, transect/site selection and placement, flow level determination, depth, velocity, and substrate/cover data acquisition, computer model construction and calibration, species evaluation and WUA

computation, analytical procedures, and further interpretation and time series analysis. Specific details on techniques for data acquisition and analysis would be contained in a comprehensive Phase 2 study plan.

This summary report will~~, at a minimum,~~ include, but is not limited to ~~descriptions of~~:

- Executive Summary
- Table of Contents
- List of Tables
- List of Figures
- Introduction
- Narratives of relevant findings by task. Specific elements to be included are listed for each subtask or task above. This section will include the methodology and analytical procedures used in the review of each item. It also will include recommendations following the review, including discussions addressing relevant questions (see above) and indicating any complications/data concerns
- Verification and/or development of habitat-flow relationships for the spawning and rearing lifestages of chinook salmon and steelhead~~;~~
- ~~Analytical procedures used to generate the relationship between streamflow and habitat index;~~
- ~~Analytical procedures used to conduct time series analysis;~~
- Presentation, discussion, and interpretation of results~~;~~
- Conclusions related to study plan goals and objectives
- References
- Appendices, and
- A description of the Phase 2 scoping process, if necessary.

Phase 2

As necessary, and as specified in the draft Phase 2 study plan potentially included in the Phase 1 report, supplemental data will be collected and evaluated. The Phase 1 summary report will describe the additional hydraulic and/or biological data needed to supplement the objectives of this study plan, including specific techniques for data acquisition and analysis.

6.0 Results and Products/Deliverables

Results

The results of all evaluations, both of existing data as well as any based upon supplemental data collection, will be presented in the form of a summary report as detailed in Task 3.

Products/Deliverables

The summary report will detail prior field data collection techniques and methods, the hydraulic, hydrologic, and habitat suitability data used in the simulations, as well as a discussion and interpretation of the results. If additional data collection is deemed necessary, the summary report will provide a complete description of the Phase 2 scoping process.

7.0 Coordination and Implementation Strategy

Coordination with Other Resource Agencies/Studies

Examination of existing hydraulic and biological data used in all prior habitat simulations will be coordinated with the appropriate agency personnel~~, once the studies and personnel have been identified~~. It is anticipated that contacts with biologists and hydraulic modelers on staff with DWR and/or their consultants will be required.

If Phase 2 is determined to be necessary, it is anticipated that additional field efforts to supplement existing habitat simulations will be made through DWR, DFG and other biologists and hydrologists currently involved with the relicensing effort. These field studies would be coordinated with other environmental studies being conducted as part of the project relicensing, such as sediment transport, recreation, riparian, and water quality studies. Coordination with National Marine Fisheries Service (NMFS) may be required if additional biological data needs to be collected on Feather River stocks of chinook salmon or steelhead.

SP-F3.2—Evaluation of Project Effects on Resident Fish and Their Habitat in the Feather River Downstream of the Fish Barrier Dam. Habitat characterization information generated under SP-F16 will be shared for evaluation of impacts in SP-F3.2.

SP-F10—Project Impacts on Anadromous Fish and their Habitat. The Feather River anadromous salmonid life history and habitat requirements information compiled for the SP-F10 study plan will be used to supplement information for the PHABSIM evaluation (Task 3A and 2B). In turn, results from SP-F16 will be instrumental in the evaluation of the various components of SP-F10 (Task 2D, 3A).

Other Environmental Work Group Study Plans

This study plan will require coordination with those individuals responsible for collecting temperature and project operation data, performing biological surveys, and conducting hydraulic and channel morphology studies, as well as with the GIS Work Group to obtain base mapping and additional resource layers to provide graphical representation of the lower Feather River and physical habitat characteristics. It is essential to determine appropriate links and abilities to share information, thereby minimizing duplication of efforts and reducing overall costs of study plan implementation. In addition to the preliminary links with fisheries study plans, identified above, completion of SP-F16 also will rely on information generated by water quality study plans (SP-W6 - water temperature) and geomorphic processes (SP-G2 - river channel substrate characterization, incipient motion analysis, channel geometry).

Engineering and Operations Work Group Study Plans

Results from hydrologic and temperature modeling studies prepared by the Engineering and Operations Work Group will be used to characterize existing and anticipated project hydrologic (SP-E2) and water temperature conditions (SP-E6), and will serve to aid in evaluating potential project effects on habitat availability.

Issue Statements Addressed by the Evaluation of Project Impacts on Instream Flows and Fish Habitat (PHABSIM) Study Plan

Issue	Description
FE9	Use Instream Flow Incremental Methodology (IFIM) or a comparable methodology to determine stream-flow needs to ensure that trout habitat quality and quantity are not reduced within project area and/or project affected areas.
~~FE15~~	~~Develop and maintain a balanced fishery.~~
~~FE32~~	~~Ongoing studies in the lower Feather River include adult and juvenile steelhead snorkel surveys and a habitat inventory, beach seine surveys to determine the temporal and spatial rearing extent of juvenile steelhead and salmon, rotary screw trap sampling of Chinook salmon to monitor the timing and number of emigrants, Chinook egg survival studies, particularly in the low-flow channel, Chinook spawning escapement surveys, redd de-watering and juvenile surveys in the Lower Reach, effects of water temperatures on juvenile steelhead rearing, steelhead creel surveys to gather adult steelhead life history data, and invertebrate research;~~
FE34	Is additional Physical Habitat Simulations modeling (PHABSIM) necessary to determine what streamflows are necessary for spawning and rearing steelhead and fall, late-fall, and spring-run Chinook salmon in the low-flow section and in the river downstream of Thermalito Afterbay;
FE35	Is riparian vegetative cover in the low-flow section and in the river downstream of Thermalito Afterbay adequate under present flow conditions for rearing steelhead and fall, late-fall, and spring-run Chinook salmon;
FE37	Under existing conditions, are there adequate amounts of suitable gravel for salmonid spawning in the low-flow section and in the river downstream of Thermalito Afterbay;
FE41	Early on and clearly identify flow rates and temperature requirements downstream of the dam;
FE44	Increase emphasis on steelhead protection and habitat and less on salmon;
~~FE45~~	~~Evaluate salmon numbers;~~
FE46	Clearly identify species, landowners along river, flow rates and temperature requirements downstream of the dam;
~~FE53~~	~~Are the present project related flow ramping/fluctuation restraints adequately protecting rearing Salmonid species from being stranded in the low-flow section and in the river downstream of Thermalito Afterbay;~~
~~FE54~~	~~Are the present project related flow ramping/fluctuation restraints adequately protecting Salmonid redds and juveniles, conserving their habitat and forage, and spawning gravel from being scoured out from the low-flow section and from the river downstream of Thermalito Afterbay;~~
~~FE55~~	~~What engineering or other reasonable and prudent solutions are available that would prevent the interbreeding of fall and spring-run Chinook salmon in the low-flow section of the Father River (migration barrier and/or flow and temperature changes in low-flow section);~~
FE56	The Feather River's low-flow reach has historically provided spawning habitat for a cold-water fishery. How have reduced flows to this stream reach affected water temperature and gravel substrate necessary for successful salmonid reproduction?
~~FE84~~	~~Evaluate indicators of hydrological alteration (IHA analysis);~~
FE86	Adequacy of current ramping rate to protect anadromous salmonids and conserve their habitats and forage. This includes providing a range of schedule of flows necessary to optimize habitat, stable flows during spawning and incubation of in gravel forms, flows necessary to ensure redd replacement in viable areas, and flows necessary for channel forming processes, riparian habitat protection and maintenance of forage communities. This also includes impacts of flood control or other project structures or operations that act to displace individuals or their forage or destabilizes, scours, or degrades habitat;
~~FE90~~	~~Adequacy of current project operating regimes and structures to optimize water quality conditions for anadromous salmonids and their habitats;~~
FE91	Current condition of habitat potentially impacted by project and alternatives to conserve or enhance anadromous salmonids;

Issue	Description
FE95	The lower Feather River provides habitat to support a variety of anadromous fish species including Chinook salmon, steelhead, striped bass, American shad and sturgeon. Potential changes in license conditions could adversely impact habitat supporting these species. Habitat investigations should evaluate the existing quality and quantity of habitat and determine alternative improvements for the various life history needs of anadromous species including flow, water temperature, instream and riparian cover, substrate and spatial area;
FE97	The habitat for fishes in the lower Feather River is affected by the flow releases from the project. Seasonal timing, volume, and rate of release all have an affect on fish habitat conditions. Potential changes in license conditions for flow releases could adversely affect habitat conditions for one or more fish species. Fishery investigations should examine the adequacy of flows for maintaining all life history needs for anadromous and resident species. There should be evaluation of potential for flow improvements in the low-flow section. Fishery investigations should be sufficient to determine how best to meet the combined needs of the various anadromous and resident fish species;
~~FE98~~	~~Fish passage is an essential survival element for anadromous species and obstructed passage can also have serious adverse impact on resident species biodiversity and populations. Both upstream and downstream unobstructed fish passage below the project should occur. Fishery investigations should examine the adequacy of passage for all species in the reaches of the lower Feather River downstream of the project. Evaluations should cover a sufficient range of flows and include examination of instream pits or gravel ponds;~~
G1	Effects of existing and future project operations on natural geomorphic processes. These include physical attributes and functions (e.g., channel morphology, channel stability, sediment transport and deposition, spawning gravel and large woody debris recruitment, habitat diversity) and subsequent effects on biological resources (e.g., aquatic macroinvertebrates, riparian vegetation) in the low-flow section and in the Feather River downstream of Thermalito Afterbay under wet and dry year criteria;
~~GE3~~	~~Alterations in stream hydrology affect the natural fluvial geomorphologic processes of a riverine system. How has the change in magnitude, frequency and timing of peak flows and rates of flow change on the Feather River affected riparian vegetation recruitment in the low-flow reach and immediately downstream of the Afterbay, under wet and dry year criteria;~~
~~GE4~~	~~Under existing conditions, are bankfull flows frequent enough to maintain channel morphology, sediment transport, habitat diversity and adequate gravels for salmonid spawning and rearing in the low-flow section and in the river downstream of Thermalito Afterbay;~~
~~GE5~~	~~Under existing conditions, are the moderate winter floods and bankfull flows adequately recruiting the amount of large woody debris needed to maintain adequate salmonid rearing habitat in the low-flow section and in the river downstream of Thermalito Afterbay;~~
~~GE20~~	~~Indicators of hydrological alteration (IHA analysis);~~
GE23	Releases that reflect nature cycles benefit biological cycles – how have changes in seasonal release patterns affected fish, invertebrates, and their habitat
W10	Effects of existing and future water releases and operations on water temperatures in the Diversion Pool, Forebay, Afterbay, Oroville Wildlife Area, low-flow section of the river and downstream areas; at the hatchery; for agriculture; and the quality and availability of habitat for salmonids and other aquatic resources.
~~WE28~~	~~Does the increase in river water temperature that results from warmer Thermalito Afterbay releases during the spring, summer, and fall months limit the amount of suitable steelhead and salmon habitat in the river downstream of Thermalito Afterbay;~~
~~WE54~~	~~Impact of project structures and operations on water quality conditions necessary to sustain anadromous salmonids and their habitat. Adequacy of current project operating regimes and structures to optimize water quality conditions for anadromous salmonids and their habitats.~~

Source: NEPA Scoping Document 1 and CEQA Notice of Preparation, DWR 2001

8.0 Study Schedule

It is anticipated that the Phase 1 Summary Report will be completed by ~~September~~ June 2002. If Phase 2 is necessary, then a schedule for the Phase 2 study plan would be provided once a decision is made regarding specific need for Phase 2 activities.

9~~8~~.0 References

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